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A new species of *Foza* Reed & Cumberlidge, 2006, from northern Madagascar (Decapoda, Brachyura, Potamoidea, Potamonautidae), with a redescription of *F. goudoti* (H. Milne Edwards, 1853) comb. n., and comments on *Skelosophusa prolixa* Ng & Takeda, 1994

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Abstract

Foza ambohitra **sp. n.** is described from Ambohitra, Antsiranana Province, northern Madagascar at 421 m elevation. This species is distinguished by characters of the carapace, the male anterior thoracic sternum, and the form of the male major cheliped and first gonopod. *Thelphusa goudoti* H. Milne Edwards, 1853, is transferred to *Foza* Reed & Cumberlidge, 2006, and redescribed, and a key to the three species of this genus is provided. Comments on the rare cave crab *Skelosophusa prolixa* Ng & Takeda, 1994, from Antsiranana Province are also included based on newly obtained material.

Keywords

Potamoidea, Potamonautidae, *Foza*, new species, Madagascar, identification key

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Introduction

The present work reports on the discovery of a new species of freshwater crab, *Foza ambohitra,* from Antsiranana Province in northern Madagascar, from material obtained over a number of years by different collectors. In addition, *Hydrothelphusa goudoti* (H. Milne Edwards, 1853) is redescribed and reassigned here to *Foza* Reed & Cumberlidge, 2006, and a key to the three species of this genus is provided. We also describe new characters of the rare cave crab *Skelosophusa prolixa* Ng & Takeda, 1994, and provide habitus photographs of a large adult male specimen.

Material

The material is housed in the collections listed below:

FMNH Field Museum of Natural History, Chicago, Illinois, USA
MNHN Muséum national d'Histoire naturelle, Paris, France
NMU Department of Biology, Northern Michigan University, Marquette, Michigan, USA
NHM The Natural History Museum, London, UK
ZRC Zoological Research Collection, Raffles Museum of Biodiversity Research, National University of Singapore

Methods

All measurements were made with digital calipers, and are given in millimetres. Carapace width (CW) is the distance across the carapace at the widest point; the carapace length (CL) is measured along the median line, from the anterior to the posterior margin; the carapace height (CH) is the maximum height of the cephalothorax from the highest point of the gastric region to the suture between thoracic sternites s2 and s3; the front width (FW) is measured along the anterior frontal margin between the base of the orbits. The following abbreviations are used: a1-a6, abdominal somites 1–6; a7, telson of abdomen; asl, above sea level; e, thoracic episternite; s4/e4, s5/e5, s6/e6, s7/e7, episternal sulci between respective thoracic sternites and episternites thoracic sternite; GO1, first gonopod; GO2, second gonopod; p1-p5, pereiopods 1–5; s4/s5, s4/s5, s5/s6, s6/s7, s7/s8, sternal sulci between respectively numbered thoracic sternites. The terminology is adapted from Cumberlidge (1999). Line drawings were prepared using a Leica MZ 16 stereobinocular microscope. Photographs were taken with a digital camera in combination with an eyepiece adapter. Post processing was done in Adobe Photoshop 7.0.

Description

***Foza ambohitra* sp. n.**
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(Figs 1–3, Table 1)

Type material. *Holotype:* adult male (CW 39.5, CL 32.4, CH 16.3, FW 8.7) northern Madagascar: Antsiranana Province, Diana Region, forest close to Ambohitra (formerly Joffreville) May 2005, 12°26′60″S, 49°7′60″E, 421 m asl, coll. R. Roy (MNHN B 30154). Paratypes: adult female (CW 37.8, CL 29.6, CH 15.5, FW 8.0), subadult female (CW 30.0, CL 23.6, CH 12.7, FW 6.6), northern Madagascar: Antsiranana Province, Réserve Spéciale d'Analamerana, Foret d'Ankavanana, 15.8 km southeast Anivorano-Nord, from partially disturbed mixed dry deciduous and humid forest, collected in early morning, 23 January 2004, 14°52′00″S, 50°15′20″E, 200 m asl, coll. S. M. Goodman (FMNH 11045); adult male (CW 38.4, CL 28.8, CH 15.0, FW 8.3), adult female (CW 35.0, CL 28.0, CH 14.3, FW 8.1), Antsiranana Province, Réserve Spéciale d'Analamerana, Foret d'Ankavanana, 15.8 km southeast Anivorano-Nord, from partially disturbed mixed dry deciduous and humid forest, collected during night at edge of small stream at forest edge, 23 January 2004, 14°52′00″S, 50°15′20″E, 200 m asl, coll. S. M. Goodman (FMNH 11046); adult male (CW 37.1, CL 29.2, CH 16.8, FW 8.1), Antsiranana Province, Réserve Spéciale d'Analamerana, Foret d'Ankavanana, 15.8 km southeast Anivorano-Nord, from partially disturbed mixed dry deciduous and humid forest, collected in late afternoon, 25 January 2004, 14°52′00″S, 50°15′20″E, 200 m asl, coll. S. M. Goodman (FMNH 11050); adult female (CW 38.0, CL 28.7, CH 15.7, FW 8.5), adult male (CW 33.2, CL 26.2, CH 14.5, FW 7.5), Antsiranana Province, Réserve Spéciale d'Analamerana, Foret d'Ankavanana, 15.8 km southeast Anivorano-Nord, from partially disturbed mixed dry deciduous and humid forest, collected in the late afternoon, 25 January 2004, 14°52′00″S, 50°15′20″E, 200 m asl, coll. S. M. Goodman (FMNH 11051); adult female (CW 39.1, CL 30.7, CH 17.1, FW 8.7) Antsiranana Province, Réserve Spéciale d'Analamerana, Foret d'Ankavanana, 15.8 km southeast Anivorano-Nord, from partially disturbed mixed dry deciduous and humid forest, collected at forest edge during night, 25 January 2004, 14°52′00″S, 50°15′20″E, 200 m asl, coll. S. M. Goodman (FMNH 11052); adult female (CW 41.4, CL 31.9, CH 17.4, FW 8.7) Antsiranana Province, Réserve Spéciale d'Analamerana, Foret d'Ankavanana, 15.8 km southeast Anivorano-Nord, from partially disturbed mixed dry deciduous and humid forest, found on ground during day, 26 January 2004, 14°52′00″S, 50°15′20″E, 200 m asl, coll. S. M. Goodman (FMNH 11054); adult female (CW 43.1, CL 34.2, CH 18.3, FW 9.9), Antsiranana Province, Réserve Spéciale d'Analamerana, Foret d'Ankavanana, 15.8 km southeast Anivorano-Nord, from partially disturbed mixed dry deciduous and humid forest, collected in late afternoon, 28 January 2004, 14°52′00″S, 50°15′20″E, 200 m asl, coll. S. M. Goodman (FMNH 11056); juvenile male (CW 22.8, CL 17.6, CH 9.4,

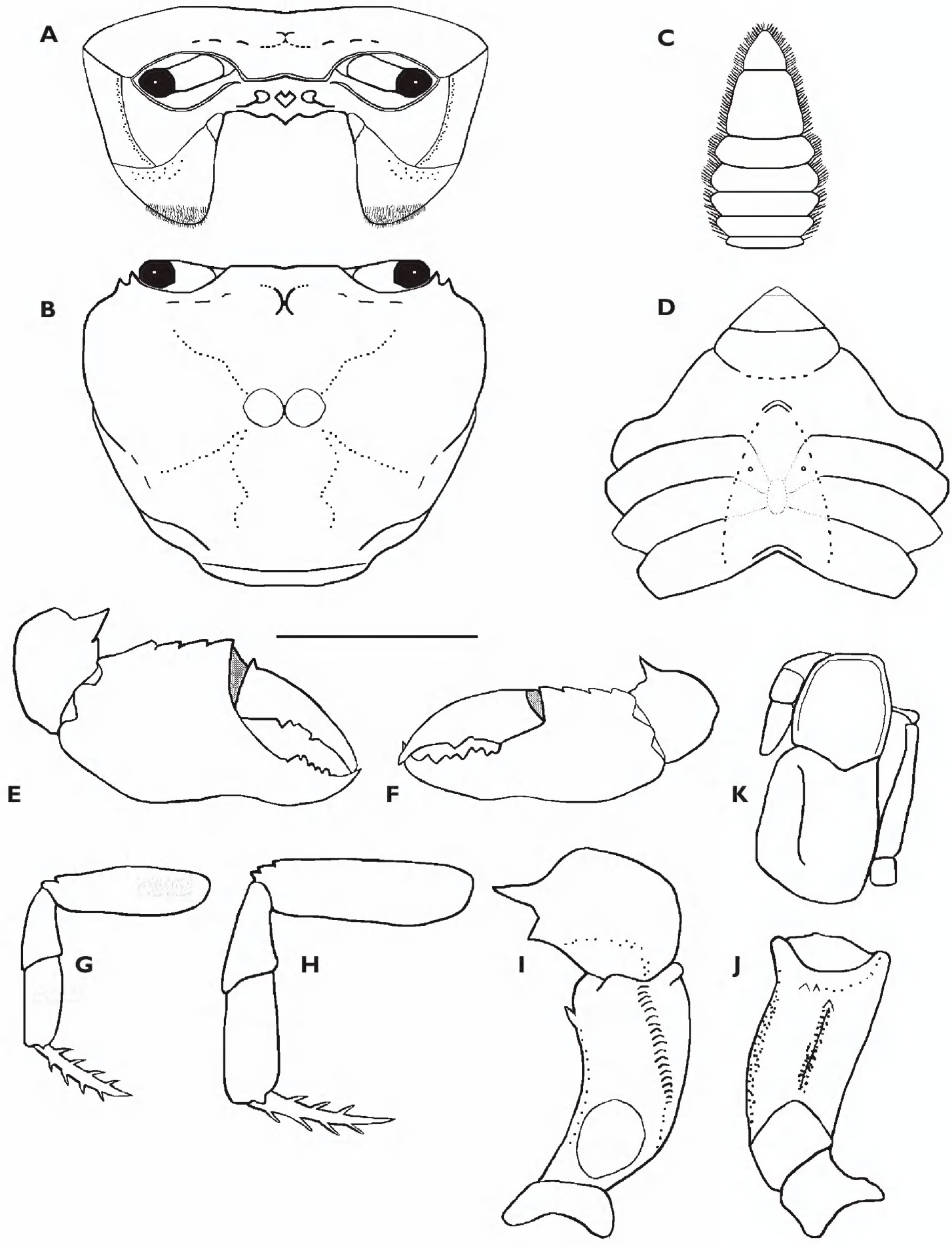

Figure 1. *Foza ambohitra* sp. n. **A** carapace, frontal view **B** carapace, dorsal view **C** male abdomen **D** male sternum **E** major (right) cheliped **F** minor (left) cheliped **G** pereiopod 3 **H** pereiopod 5 **I** carpus and merus of major cheliped, dorsal view **J** merus of major cheliped, ventral view **K** third maxilliped. Scale bar = 20 mm, **A–J**; 7.5 mm, **K**.

FW 4.7) Antsiranana Province, Réserve Spéciale d'Analamerana, 8.6 km southeast Menagisy, Foret d'Analabe, along Bobakindro River, partially disturbed dry deciduous forest, collected early morning, 17 January 2004, 12°42′00″S, 49°28′00″E, 40 m asl, coll. S. M. Goodman (FMNH 11060); adult male (CW 43.0, CL 31.6, CH 17.7, FW 11.6), Toamasina Province, Montagne d'Akirindro, 7.6 km, 17–21 March 2003, 15°17′00″S, 49°32′34″E, NNE Ambinantelo, 600 m asl, coll. P. Naskrecki (NMU PN 17–21.3.2003).

Diagnosis. Anterolateral margin lined by small granules. Suborbital, subhepatic, pterygostomial regions smooth with small field of granules at junction of longitudinal, vertical sutures. Outer face of merus of cheliped (pereiopod 1) smooth, granules present on upper margin only. Sternal sulcus s3/s4 complete, U-shaped, not meeting sterno-abdominal cavity. Terminal article of GO1 short, slim, tapered, with distinct raised rounded shoulder on external margin, slightly lower than junction with terminal article.

Description. Based on holotype, adult male. Carapace outline transversely oval, very high (CH/FW 1.90); front narrow (FW/CW 0.22), deflexed; epibranchial tooth small, pointed, advanced in position, almost touching exorbital tooth; anterolateral margin evenly curved outward, lined by small granules, continuous with posterolateral margin, latter margin with faint or absent striae; postfrontal crest faint to absent, epigastric crests faint, positioned forward on front almost touching frontal margin, postorbital crests faint; deep mid-groove between epigastric crests forked posteriorly; cardiac, urogastric grooves faint, semicircular grooves deep; cervical grooves faint, long, not meeting postorbital crest. Suborbital region of carapace smooth, subhepatic region smooth, pterygostomial region smooth except for setae on lower margin, small field of granules at junction between longitudinal, vertical sutures; vertical sulcus on carapace sidewall curved, granular, running downward from base of epibranchial tooth to epimeral sulcus.

Epistomial tooth triangular, deflexed, edges smooth. Mandibular palp bilobed. Exopod of third maxilliped reaching to lower half of merus, exopod with short flagellum, ischium with deep vertical groove, curving distally toward medial margin. Sternal sulcus s1/s2 short, very faint; sternal sulcus s2/s3 completely crossing sternum; sternal sulcus s3/s4 with broad U-shaped groove, deep at edges, faint in middle; anterior sterno-abdominal cavity lacking setae. Sternal sulcus s4/s5 meeting abdomen at abdominal sulcus at a7/a6; sternal sulcus s6/s7 meeting a6 one half of segment length from a6/a5. Episternal sulci s4/e4, s5/e5, s6/e6, s7/e7 absent, smooth.

Dactylus of both chelipeds relatively slender, approximately one-third height of palm, edges smooth except for 2 distinct teeth, one positioned basally, one half way along; upper margin of dactylus smooth; lower margin of propodus slightly indented. Fixed finger of propodus of major (right) cheliped slender with 3 large molars in proximal region (first 2 fused basally, third single) followed by series of small teeth. First carpal tooth on inner margin of carpus of cheliped large, pointed; second carpal tooth smaller, pointed, followed by a large granule. Medial, lateral margins of inferior face of merus of cheliped distinctly toothed, inferior face with

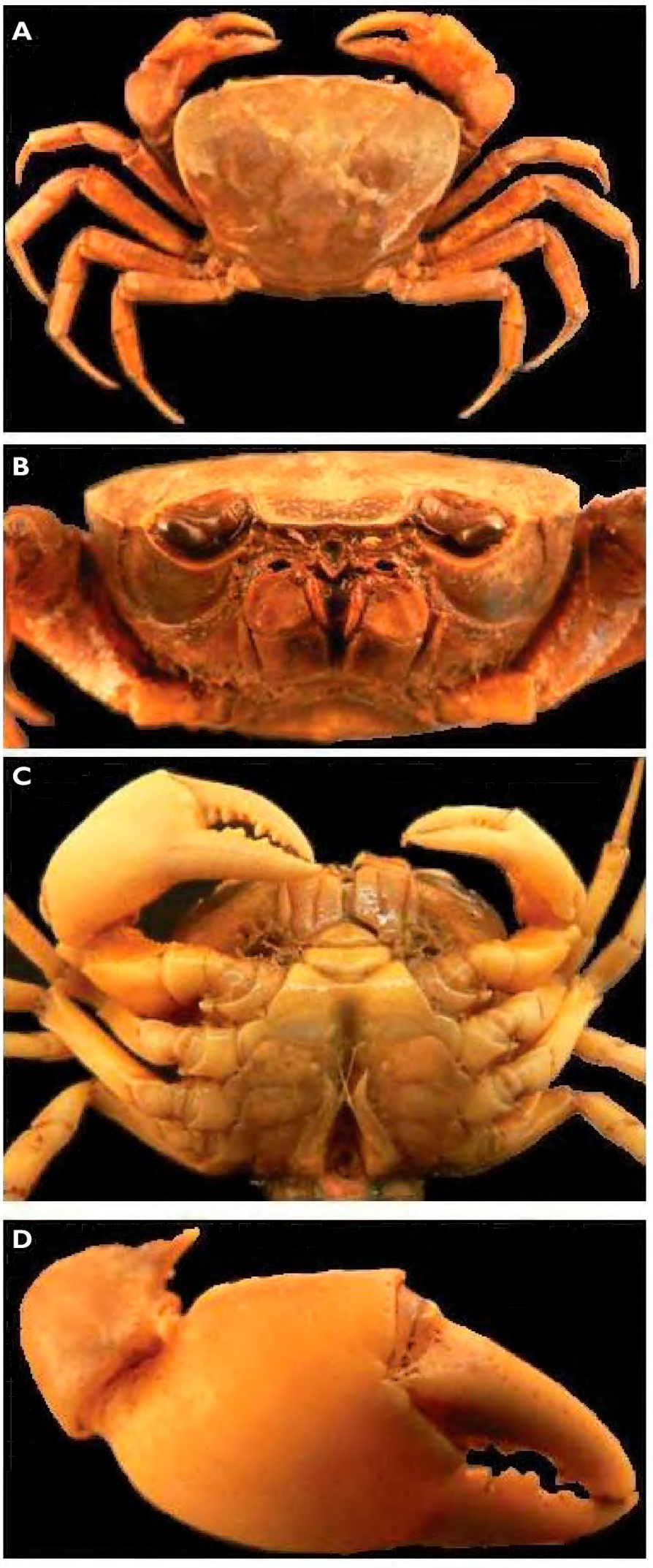

Figure 2. *Foza ambohitra* sp. n. **A** dorsal view **B** frontal view **C** sternal view **D** major (right) cheliped. **A**, **B** adult female (FMNH 11056), CW 43.1 mm **C**, **D** holotype, adult male, CW 39.5 mm.

pointed, granulated distal meral tooth; superior margin of merus of cheliped roughened by granules and short striae; outer face of merus smooth; granules on medial margin of merus, ischium of cheliped smooth, inferior margin of ischium rounded, smooth. Walking legs (p2-p5) elongated (ratio of merus length of p5 to CW 0.3), slender, inner margins of p2 to p5 propodi smooth. Male abdomen triangular, tapered distally, widest at a3, narrowest at a7 (telson); telson outline forming straight-sided triangle with broad base, rounded apex.

Terminal article of GO1 short (ratio of length of terminal article to subterminal segment 0.25), slim, tapered, directed slightly outwards, straight, smooth, apical

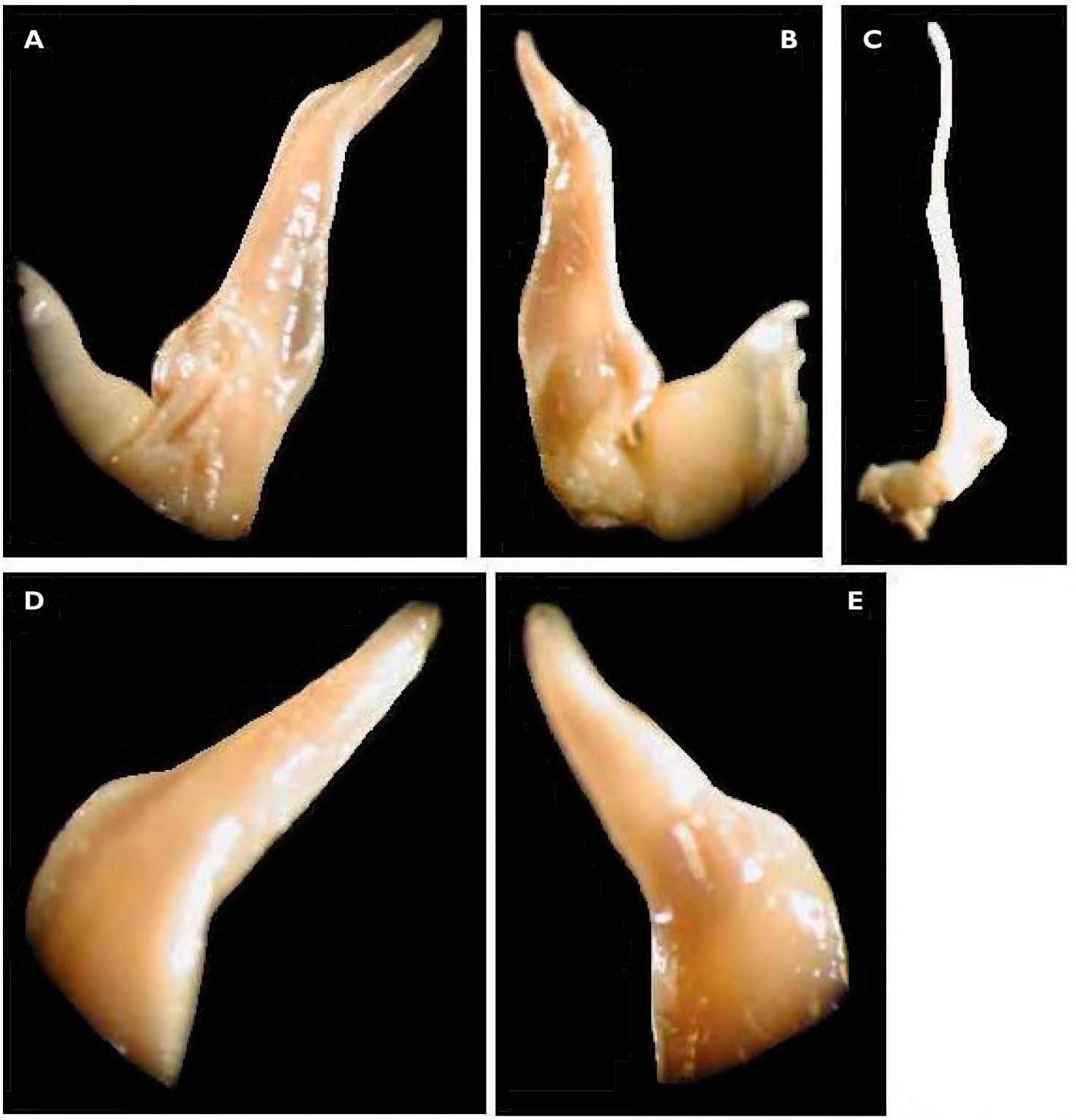

Figure 3. *Foza ambohitra* sp. n. **A** left GO1, ventral view **B** left GO1, dorsal view **C** left GO2, ventral view **D** terminal article of left GO1, close-up, ventral view **E** terminal article of left GO1, close-up, dorsal view. Holotype, adult male, length of the terminal article measured along the mid-line of the dorsal face from tip to dorsal membrane = 8.2 mm.

opening narrow; subterminal segment with junction between terminal article, subterminal segment not clearly visible on ventral side. Terminal article, subterminal segment separated on dorsal side by broad, trapezoid dorsal membrane; superior margin of dorsal membrane formed by diagonal basal margin of terminal article, inferior margin of membrane formed by diagonal J-shaped distal edge of subterminal segment; lateral margin of dorsal membrane broad, medial margin of membrane narrow, forming medial junction between subterminal segment, terminal article. Subterminal segments of GO1, GO2 subequal, but terminal article of GO2 much longer than terminal article of GO1. Terminal article of GO2 flagellum-like, about 2/3 length of subterminal segment, reaching anterior margin of sterno-abdominal cavity; tip of flagellum curving inward distally; distal parts of flagella of left, right GO2s crossing medially.

Comparisons. *Foza ambohitra*, sp. n., is assigned to the genus *Foza* on the basis of characters that it shares with *F. raimundi* Reed & Cumberlidge, 2006, the type-species of the genus (Reed and Cumberlidge, 2006). The two species share a weak postfrontal crest, a narrow frontal margin of the carapace (FW/CW 0.22 *F. ambohitra*, 0.25 *F. raimundi*) and a GO2 terminal article that curves inward distally; and the epibranchial tooth of both species is in a forward position, almost touching the exorbital tooth. *Foza ambohitra* can be distinguished from *F. raimundi* as follows: the terminal article of GO1 of *F. ambohitra* is cone-shaped and tapered (Fig. 2A), while that of *F. raimundi* is tube-shaped (Reed and Cumberlidge, 2006: Fig. 2B–D); both the superior part of the pterygostomial region and the sterno-abdominal cavity of *F. ambohitra* lack setae (Fig. 1D, 2C), whereas setae are present in these regions in *F. raimundi*; the anterolateral margin of *F. ambohitra* is granular and the posterolateral margin is smooth (Fig. 1A), whereas the anterolateral margin of *F. raimundi* is smooth and the posterolateral margin is carinated (Reed and Cumberlidge, 2006: Fig. 1B); and the major cheliped of *F. ambohitra* has three large molars (Fig. 1E) whereas that of *F. raimundi* has one large fused molar (Reed and Cumberlidge, 2006: Fig. 1E). The three species of *Foza* are compared in Table 1. The differences between *Foza* and the other Malagasy freshwater crab genera are discussed by Reed and Cumberlidge (2006).

Etymology. Ambohitra is the modern name of Joffreville, a French colonial town in northern Madagascar, near where the specimens described here were collected. Ambohitra is a noun in apposition.

Distribution. *Foza ambohitra* is found in the Analamerana Mountains (12°44′00″S, 49°36′00″E), as well as the Ankavanana River (14°52′00″S, 50°15′20″E) and the Bobakindro River (12°42′00″S, 49°28′00″E) in Antsiranana Province in northeastern Madagascar.

Habitat. Partially disturbed mixed dry deciduous and humid forest in northern Madagascar.

Redescription

Foza goudoti (H. Milne Edwards, 1853), **comb. n.**
Thelphusa goudoti H. Milne Edwards, 1853: 212. A. Milne-Edwards 1869: 172; 1887: 135.
Telphusa goudoti.– De Man 1892: 235.
Potamon goudoti.– De Man 1898: 434.
Potamon (*Potamon*) *goudoti.*– Rathbun, 1904: 305, 306. Balss 1929: 355.
Potamon (*Geothelphusa*) *methueni* Calman, 1913: 920.
Bottia goudoti.– Pretzmann 1961: 164.
Gecarcinautes goudoti.– Bott 1965: 338, 339. Cumberlidge 1997: 585; 1998: 209.
Hydrothelphusa goudoti.– Cumberlidge and Sternberg 2002: 56–59. Ng et al., 2008: 169.

Type locality. Madagascar. *Thelphusa goudoti*: Madagascar, road between Bombetok and Tananarive. *Potamon* (*Geothelphusa*) *methueni*: Imerimandrosa.

Type material. Adult male (CW 45.3, CL 34.4, CH 20.7, FW 10.7), adult female (CW 40.5, CL 32.1, CH 17.0, FW 10.0), 1987, purchased live in market in Antananarivo by N. Cumberlidge (NMU NC 1987); adult male (CW 38.0, CL 28.1, CH 15.1, FW 10.2), adult male (CW 34.4, CL 27.5, CH 14.5, FW 8.4), adult female (CW 38.2, CL 33.1, CH 17.0, FW 9.5), adult female (CW 32.0, CL 25.1, CH 13.6, FW 8.2), from a lake near Antananarivo, coll. H. Morioka (ZRC 2000.2303).

Diagnosis. Frontal margin of carapace relatively narrow (FW/CW 0.25), sharply deflexed. Epibranchial tooth small, positioned forward close to exorbital tooth. Epigastric, postorbital crests fused forming long horizontal postfrontal crest. Anterolateral margin posterior to epibranchial tooth raised, granular; anterolateral region smooth with striae on posterolateral margin. Pterygostomial region of carapace sidewall lacking setae. Subhepatic region smooth, granules in suborbital and pterygostomial regions. Sternal sulcus s3/s4 complete, v-shaped. Terminal article of GO1 with medial flap near junction. Terminal article of GO2 long, not curving inward distally.

Comparisons. Cumberlidge and Sternberg (2002) assigned *T. goudoti* to *Hydrothelphusa* on the basis of its bilobed mandibular palp, but commented on the differences in a number of other characters of the carapace between this species and the others included in that genus. For example, the exorbital and epibranchial teeth of *F. goudoti* are both low and blunt and positioned close together, and the carapace is very wide (CW/FW 3.9) and highly arched (CH/FW 1.6). In the other species of *Hydrothelphsua* these teeth are large and well spaced, and the carapace is not noticeably widened or inflated (Cumberlidge and Sternberg, 2002). This taxon is transferred here to the genus *Foza* because it shares a number of important taxonomic characters with both *F. raimundi* and *F. ambohitra* (Table 1).

Table 1. Comparison of the morphological characters of the species of genus *Foza*.

Character	*F. raimundi* [1]	*F. goudoti* [2]	*F. ambohitra* [3]
GO1 terminal segment	tube-shaped, not tapering	cone-shaped, tapering	cone-shaped, tapering
GO2 terminal segment	curving inward distally	straight, no distal curve	curving inward distally
Sterno-abdominal cavity	dense setae	no setae	no setae
Sternal sulcus s3/s4	complete, u-shaped	complete, v-shaped	complete, u-shaped
Postfrontal crest	faint, incomplete	distinct, complete	faint, incomplete
Anterolateral surface of carapace	smooth	smooth	granular
Anterolateral margin	smooth	raised, granular	smooth
Posterolateral surface of carapace	with carinae	with carinae	smooth
Cervical grooves	short	long, distinct	long, faint
Suborbital region	small granules	faint granules	smooth
Subhepatic region	conspicuous carinae	smooth	smooth
Pterygostomial region	dense setae on entire region, lacking granules	setae absent, granules present	setae near inferior margin only, small field of granules at junction of vertical and epimeral sutures
Major cheliped	one fused molar	more than one molar	three distinct molars

[1] Reed and Cumberlidge, 2006; [2] Cumberlidge and Sternberg, 2002; [3] present work.

Key to the species of *Foza*

1 Terminal article of GO1 tube-shaped; dense setae on sterno-abdominal cavity and pterygostomial region; conspicuous striae present on subhepatic region; cervical grooves short; major cheliped with single fused molar ..... ***F. raimundi* Reed & Cumberlidge, 2006**

– Terminal article of GO1 cone-shaped, tapering to a pointed tip; setae lacking on sterno-abdominal cavity and superior part of pterygostomial region; subhepatic region smooth, smooth; cervical grooves long; major cheliped with more than one fused molar **2**

2 Terminal article of GO2 long, straight; anterolateral region of carapace surface smooth; striae present on posterolateral region; postfrontal crest distinct, complete; suborbital, pterygostomial, subhepatic regions smooth, lacking granules at intersection of longitudinal, vertical sutures ..... ***F. goudoti* (H. Milne Edwards, 1853)**

– Terminal article of GO2 long, strongly curved inward at tip; anterolateral region of carapace surface with fields of striae; posterolateral region smooth;

postfrontal crest weak, incomplete; suborbital, pterygostomial, subhepatic regions with small field of granules at intersection of longitudinal, vertical sutures ..... ***F. ambohitra* sp. n.**

Remarks on *Skelosophusa prolixa* Ng and Takeda, 1994

(Fig. 4)

The first author discovered five specimens from northern Madagascar in the unidentified collection of the NHM (NHM 2009.119, NHM 2009.120 -121, NHM 2009.122, NHM 2009.123, NHM 2009.124) that proved to belong to *Skelosophusa prolixa*. All of these specimens were collected from Riviére Cave, Cañon Forestier, Ankarana, 60 km south of Diego Suarez, northern Madagascar, 8 August-27 September 1986, by N. W. Lear and S. U. Fowler. Although the locality is similar to that reported for the holotype, it may be possible that these specimens are topotypic, and were collected at the same time as the original type series. However, it is difficult to be certain of this because the date of collection and the names of the collectors were not supplied in the original description (Ng and Takeda, 1994). *Skelosophusa prolixa* was previously known only from two specimens collected from this same locality. The holotype described by Ng and Takeda (1994) has a CW of 25.6 mm and CL of 18.8 mm; these two measurements give a cw/cl ratio of 1.3 (compared to 1.4 for the present specimens). This species possesses a number of adaptations (e.g. normal length eyestalks but

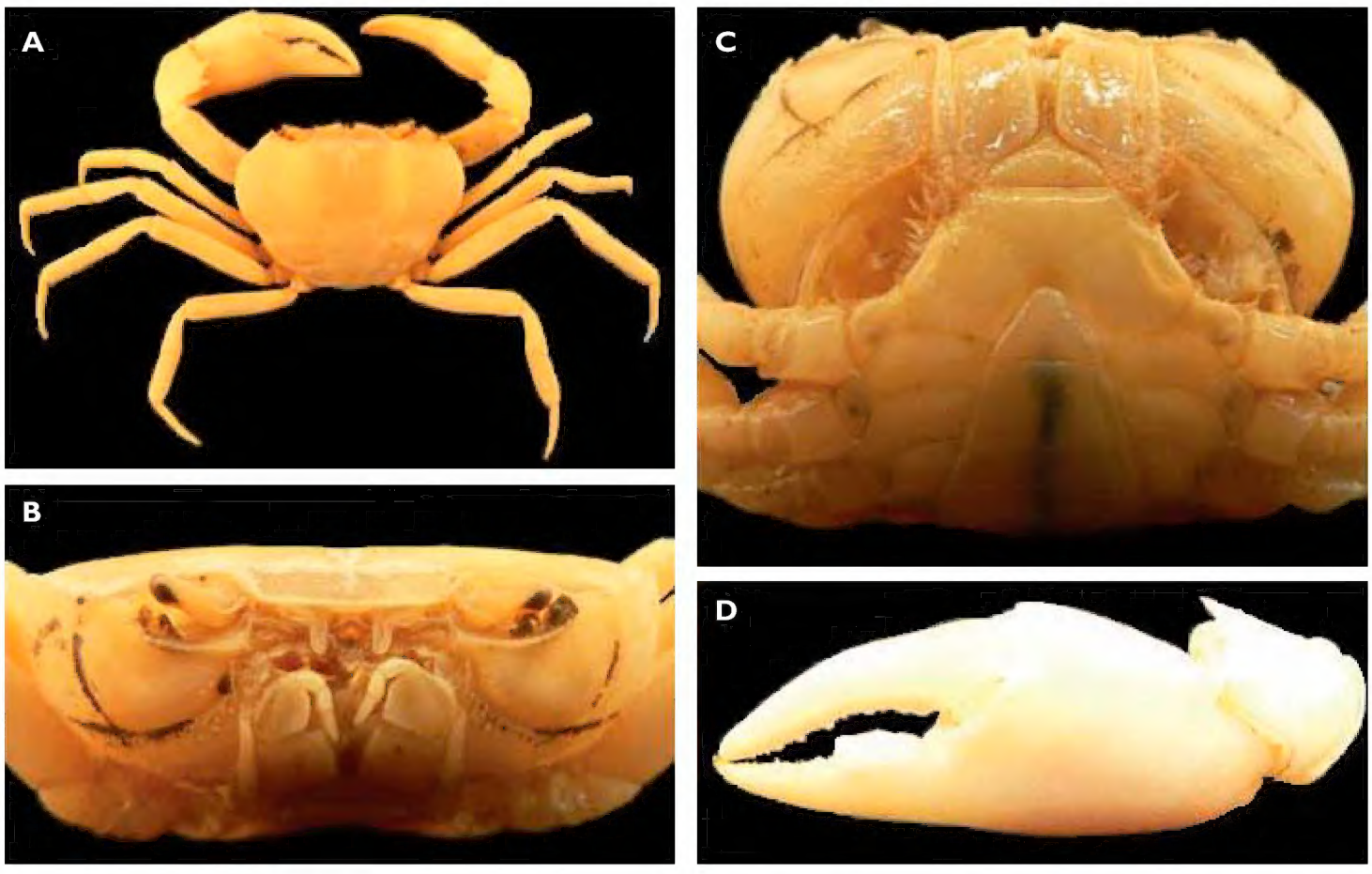

Figure 4. *Skelosophusa prolixa*. **A** dorsal view **B** frontal view **C** sternal view **D** major (left) cheliped. Adult male (NHM 2009.122), CW 29.3 mm.

with reduced corneas, lack of pigmentation of the carapace and legs, and extremely long ambulatory legs, p2-p5) typical of true cave-adapted species of freshwater crabs (Ng and Takeda, 1994). The adult male specimen among the new material photographed here (Fig. 4A–D) (CW 29.3 mm) is larger than the holotype male (CW 25.6 mm) and shows characters of the cheliped that have not previously been described. For example, the immovable finger of the major cheliped of *S. prolixa* has one large, fused molar tooth in adults, whereas that of the holotype male, a smaller specimen, has only small teeth (Ng and Takeda, 1994).

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